AMPLIFIER RESEARCH

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EC Declaration of Conformity

We; Amplifier Research
160 School House Road
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declare that as of 1997, our product(s);

the Model 500A100A series amplifiers

to which this declaration relates is in compliance with the requirements of the EEC EMC Directive (89/336/EEC) and Low Voltage Directive (73/23/EEC) in accordance with the relative standards listed below:

EMC:

EN 50082-2 : 1995
Electromagnetic compatibility - Generic immunity standard
Part 2: Industrial environment

EN 55011 : 1991
Electromagnetic emissions requirements for Industrial, Scientific and Medical (ISM) Equipment
Group 1, Class A

Safety:

IEC 1010-1 : 1990 + A1, A2

The CE marking is affixed on the device according to the EC Directives.

Donald R. Shepherd
President

Instructions for European EMC Conformity

⚠ WARNING

It is the responsibility of the user of this equipment to provide electromagnetic shielding, filtering and isolation which is necessary for EMC compliance to Directive 89/336/EEC. The equipment must therefor be operated in a shielded area which provides a sufficient level of attenuation to meet the radiated emissions and immunity specifications. All AC, DC and Control lines connected to the equipment and entering or exiting the shielded area must have sufficient isolation to meet the conducted emissions and immunity specifications. The following minimum levels are suggested for use in accordance with the rated power of the equipment.

Rated Power	Minimum shielding attenuation	Minimum line isolation
100 watts	50 dB	50 dB
101 - 1000 watts	60 dB	60 dB
1001 - 10,000 watts	70 dB	70 dB

Since this equipment is designed to generate high levels of Radio Frequency energy, it is also essential that the user read and follow the "Instructions for Safe Operation" in this manual. If other equipment is operated in the shielded room it may be disturbed by the amplifier.

⚠ ACHTUNG

Der Benutzer dieses Gerätes ist dafür verantwortlich, daß die elektromagnetische Abschirmung und Filterung gewährleistet ist, welche gemäß Richtlinie 89/336/EEC notwendig ist. Das Gerät muß deshalb in einem geschirmten Raum betrieben werden, welcher eine ausreichenden Schirmung bietet, um die Emissions- und Störfestigkeitsspezifkation einzuhalten. Alle Wechsel- und Gleichspannungsleitungen sowie Steuerleitungen, die mit dem Gerät verbunden sind und in den geschirmten Raum von außen hereingeführt werden, müssen ausreichend gefiltert sein, um die Emissionsspezifkation einzuhalten. Es werden folgenden Minimalwerte der Schirmdämpfung und Filterung in den unterschiedlichen Leistungsklassen empfohlen.

Hochfrequenzleistung	min. Schirmdämpfung	min Filterdämpfung
100 Watt	50 dB	50 dB
101-1000 Watt	60 dB	60 dB
1001-10.000 Watt	70 dB	70 dB

Falls andere elektrische oder elektronische Geräte gleichzeitig mit dem Gerät betrieben werden, kann es zu Beeinflussungen kommen. Da das Gerät zur Erzeugung von Hochfrequenzenergie dient ist es daher auch unbedingt notwendig, daß der Benutzer die Sicherheitsvorschriften in der Bedienungsanleitung liest und einhält.

⚠ AVERTISSEMENT

Il est de la responsabilité de l'utilisateur de cet équipement d'assurer la protection électromagnétique, le filtrage et l'isolation nécessaires, afin de se conformer à la directive 89/336/EEC concernant la C.E.M. Par conséquent, cet équipement doit être mis en fonctionnement dans une enceinte d'atténuation suffisante pour satisfaire aux spécifications d'émissivité et de susceptibilité. Toutes les alimentations alternatives, continues ainsi que les liaisons de contrôle connectées à cet équipement, qui entrent ou sortent de cette enceinte doivent avoir une isolation suffisante pour satisfaire aux spécifications concernant les émissions conduites et d'immunité. Pour une utilisation conforme, les niveaux d'atténuation minimums suivants sont suggérés en fonction de la puissance de sortie de l'équipement:

Puissance de sortie	Atténuation minimum de l'enceinte	Isolation minium de la ligne
100 Watts	50 dB	50 dB
101 à 1.000 Watts	60 dB	60 dB
1.001 à 10.000 Watts	70 dB	70 dB

Puisque cet équipement est destiné à générer de forts niveaux R.F., il est essentiel que l'utilisateur se conforme aux instructions de sécurité indiquées dans ce manuel. Tout autre équipement en fonctionnement dans la cage de Faraday peut-être perturbé par l'amplificateur.

⚠ INSTRUCTIONS FOR SAFE OPERATION

BEFORE APPLYING POWER

Review this manual and become familiar with all safety markings and instructions.

Verify that the equipment line voltage selection is compatible with the main power source.

Protection provided by the equipment may be impaired if used in a manner not specified by Amplifier Research.

INTENDED PURPOSES

This equipment is intended for general laboratory use in a wide variety of industrial and scientific applications. It is designed to be used in the process of generating, controlling and measuring high levels of electromagnetic Radio Frequency (RF) energy. Therefore, the output of the amplifier must be connected to an appropriate load such as an antenna or field-generating device. It is the responsibility of the user to assure that the device is operated in a location which will control the radiated energy such that it will not cause injury and will not violate regulatory levels of electromagnetic interference.

HAZARDOUS RF VOLTAGES

The RF voltages on the center pin of the RF output connector can be hazardous. The RF output connector should be connected to a load before AC power is applied to the amplifier. Do not come into contact with the center pin of the RF output connector or accessories connected to it. Place the equipment in a non-operating condition before disconnecting or connecting the load to the RF output connector.

SAFETY GROUND

This equipment is provided with a protective earth terminal. The main power source to the equipment must supply an uninterrupted safety ground of sufficient size to the input wiring terminals, power cord, or supplied power cord set. The equipment **MUST NOT BE USED** if this protection is impaired.

PHYSICAL DAMAGE

The RF amplifier should not be operated if there is physical damage, missing hardware or missing panels.

MAINTENANCE CAUTION

Adjustment, maintenance, or repair of the equipment must be performed only by qualified personnel. Hazardous energy may be present while protective covers are removed from the equipment even if disconnected from the power source. Contact may result in personal injury. Replacement fuses are required to be of specific type and current rating.

⚠ INSTRUCTIONS FOR SAFE OPERATION *(CONTINUED)*

SAFETY SYMBOLS

This symbol is marked on the equipment when it is necessary for the user to refer to the manual for important safety information. This symbol is indicated in the Table of Contents to assist in locating pertinent information.

Dangerous voltages are present. Use extreme care.

CAUTION: The caution symbol denotes a potential hazard. Attention must be given to the statement to prevent damage, destruction, or harm.

Indicates protective earth terminal.

RANGE OF ENVIRONMENTAL CONDITIONS

This equipment is designed to be safe under the following environmental conditions:

Indoor use

Altitude up to 2000M

Temperature of 5°C to 40°C

Maximum relative humidity 80% for temperatures up to 31°C. Decreasing linearity to 50% at 40°C.

Mains supply voltage fluctuations not to exceed ± 10% of the nominal voltage or minimum and maximum autoranging values.

Pollution degree 2: Normally non-conductive with occasional condensation

While the equipment will not cause hazardous condition over this environmental range, performance may vary.

COOLING AIR

Care should be exercised not to block the cooling air inlets or outlets. Cooling air blockage can result in damage to the RF amplifier or intermittent shut-downs.

TABLE OF CONTENTS

TABLE OF CONTENTS *(CONTINUED)*

SECTION I

GENERAL INFORMATION

1.1 GENERAL DESCRIPTION

The Model 500A100A is a self-contained, air cooled, broadband, completely solid state Radio Frequency (RF) amplifier designed for applications where instantaneous bandwidth and high gain are required. Push-pull circuitry is utilized in all high-power stages in the interest of lowering distortion and improving stability. The Model 500A100A, when used with an RF sweep generator, will provide a minimum of 500 watts of swept power.

Special features incorporated into the Model 500A100A include the following:

- A front panel 4-line **vacuum fluorescent display (VFD)** for monitoring amplifier status and forward or reflected output power.
- **Automatic Level Control (ALC)**, which can be controlled by internal circuits or by an external input with front panel control of the ALC Threshold.
- **Pulse input capability.**
- **RF output level protection.**
- **An internal RF detector**, which provides an output for use in self-testing or operational modes.
- **A front panel gain control** for adjusting the amplifier's gain when operating the amplifier in the "Manual" mode.
- Provisions are made for **remote control of all operating functions of the amplifier via IEEE-488 and RS-232 computer protocols**.

Protection is provided by DC current and voltage sensing of each of the final RF amplifier modules.

Housed in a stylish, contemporary cabinet, the Model 500A100A provides readily available RF power for typical applications such as RF susceptibility testing, antenna and component testing, wattmeter calibration, and use as a driver for higher power amplifiers.

1.2 SPECIFICATIONS

Refer to the "Amplifier Research Data Sheet" on the following page for detailed specifications.

1.3 POWER SUPPLIES

This unit has two (2) regulated power supplies with a total power consumption of approximately 2000 watts. One supply is a self-contained switching regulated unit with dual output voltages of +38 Volts Direct Current (VDC) and +28VDC. The +38VDC output supplies the final RF amplifiers with B+ voltage. The +28VDC output is routed to the regulator module. The regulator module generates the following voltages: +26VDC Fan Power and filtered 28VDC for the driver module

The other power supply generates standby voltages of +/-15VDC and +5VDC to operate all front panel controls and remote operation circuitry. Primary circuit protection is provided by circuit breaker CB1 and internal fusing on each of the two supplies.

1.4 PROTECTION CIRCUITS

Features incorporated into this unit include RF output level protection circuits, thermal protection circuits, internal DC level sensing and monitoring circuits which sense the input current to each of the final amplifier modules. Activation of the RF power overload adjustment, (which is adjusted to approximately 450 watts reflected power and 550 watts forward power minimum), will initiate limiting in the low-level driver of the amplifier string and sound an audible alarm. In the event that the limiting circuits cannot keep the amplifier's power levels below the set points, the protection circuits will initiate a shut-down of the final RF amplifier, light the fault LED on the front panel, and place the unit into the "Standby" mode. Both forward and reflected power can be continuously monitored on the front panel 4-line VFD. A front panel **RESET** button is also provided to permit re-powering of the amplifier if transient fault conditions occur.

1.5 INSTALLATION

Before proceeding, thoroughly inspect the amplifier for signs of physical damage which may have been incurred during shipment and completely read the following installation and operating instructions, paying special attention to all **CAUTION** notes.

1.5.1 Location

Select an operating location that will permit air to circulate freely around the amplifier's cabinet. The Model 500A100A utilizes air cooling and should be located where the normal flow of air into or exiting from the unit will not be restricted, diverted, or re-circulated through the unit itself; in particular, the flow of warm air exiting the rear of the amplifier should not be impeded.

Do not position the unit next to a wall or other equipment that would cause a restriction of air flow into or out of the unit.

1.5.2 Power

The Model 500A100A is designed to operate using AC primary power of 180–264 Volts Alternating Current (VAC), 47–440 Hz single phase, 2000 watts maximum, at a power factor of .99 typical.

1.5 INSTALLATION *(CONTINUED)*

1.5.2 Power *(continued)*

CAUTION:

DANGEROUS VOLTAGES ARE PRESENT IN THE MODEL 500A100A WHENEVER THER UNIT IS PLUGGED INTO AN AC OUTLET. ALWAYS DISCONNECT THE UNIT FROM THE MAIN POWER LINE WHEN SERVICING IT. PLEASE NOTE THAT NEITHER THE KEYLOCK SWITCH NOR THE POWER SWITCH WILL COMPLETELY SHUT OFF THE UNIT'S AC POWER.

Because of the variety of power systems available internationally, line cords are not shipped with service connection plugs. The user must determine and install the appropriate plug to line cord.

The plug shall be safety rated for 16 amps at 250VAC. The safety ground shall be used under all conditions. Prior to use, the molded IEC 320 connector shall be installed fully into the receptacle mounted on the back of the Model 500A100A. The connector lock shall be tightened so that the clamp firmly grips the connector on the power cord, as a partially mated connector could cause a fire.

SECTION II

OPERATING INSTRUCTIONS

2.1 GENERAL

Operation of the Model 500A100A broadband amplifier is quite simple. The amplifier's input signal, whether swept or fixed in frequency, is fed into the jack marked **"RF INPUT,"** and the amplifier's output signal is taken from the jack labeled **"RF OUTPUT."** The unit is turned on by activating the front panel **POWER** switch. In the event of a unit malfunction, protection is provided a circuit breaker located on the unit's rear panel.

⚠ CAUTION:

THE MODEL 500A100A AMPLIFIER IS NOT CRITICAL IN REGARD TO SOURCE AND LOAD VOLTAGE STANDING WAVE RATIO (VSWR) AND WILL REMAIN UNCONDITIONALLY STABLE WITH ANY MAGNITUDE AND PHASE OF SOURCE AND LOAD VSWR. IT HAS ALSO BEEN DESIGNED TO WITHSTAND, WITHOUT DAMAGE, RF INPUT POWER LEVELS UP TO TWENTY (20) TIMES ITS RATED INPUT OF 1MW. HOWEVER, SIGNAL LEVLES HIGHER THAN 20MW OR TRANSIENTS WITH HIGH PEAK VOLTAGES CAN DAMAGE THE AMPLIFIER. ALSO, ACCIDENTAL CONNECTION OF THE MODEL 500A100A'S OUTPUT TO ITS INPUT (EITHER THROUGH DIRECT CONNECTION OR PARASITIC FEEDBACK PATHS) WILL CAUSE OSCILLATIONS THAT MAY PERMANENTLY DAMAGE THE UNIT'S INPUT TRANSISTORS.

2.2 CONTROL AND INDICATOR FUNCTIONS

The Model 500A100A's front panel is shown in **Figure 2-1**; the unit's rear panel features are detailed in **Figure 2-2**.

2.2.1 Keylock Switch

The Keylock Switch is provided for protection from unauthorized use or unexpected remote control of the amplifier. The amplifier can only be controlled from the front panel when the Keylock Switch is in the **LOCAL** position. Likewise, the unit can only be controlled remotely when the Keylock Switch is in the **REMOTE** position. Placing the Keylock Switch in the **INHIBIT** position places the amplifier in standby and prohibits any control of the amplifier.

2.2.2 POWER Switch

The momentary **POWER** switch turns the main power to the amplifier on and off. The status of the green light-emitting diode (LED) in the switch indicates whether the amplifier's power is on or off. The 4-line display is active when power is on.

2.2 CONTROL AND INDICATOR FUNCTIONS *(CONTINUED)*

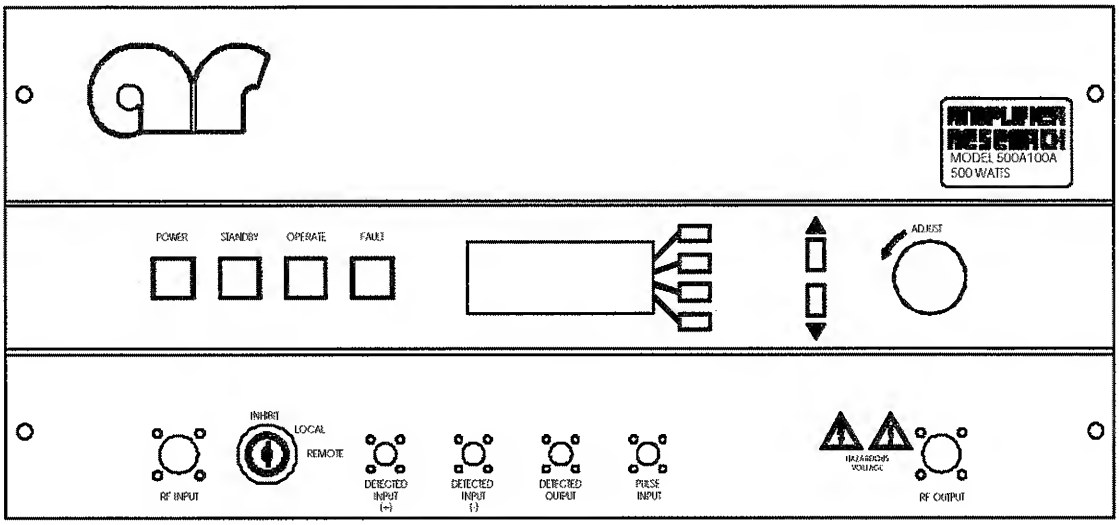


Figure 2-1
Front Panel Drawing

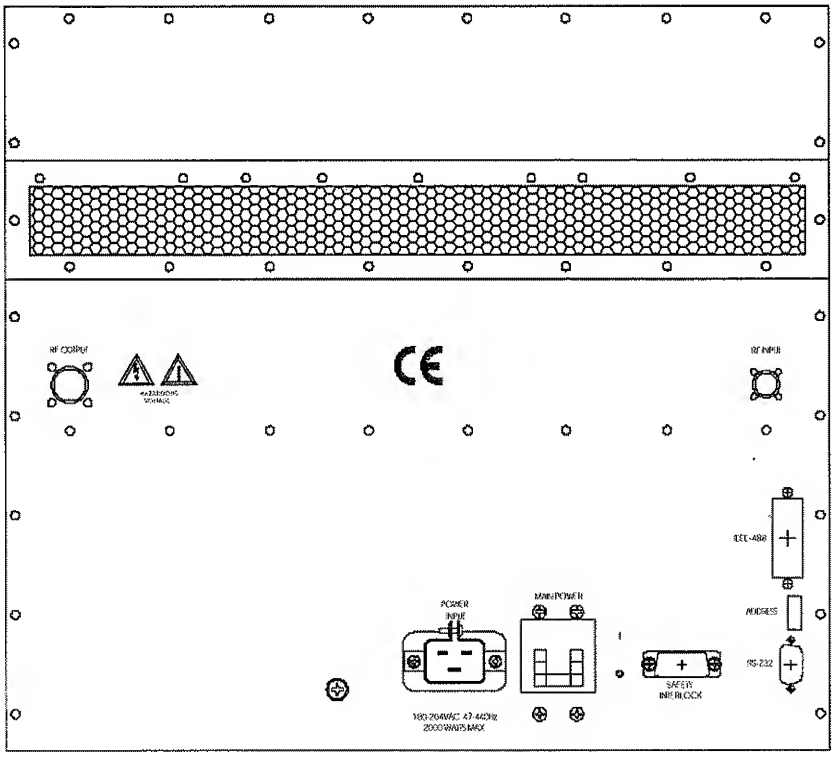


Figure 2-2
Rear Panel Drawing

2.2.3 STANDBY Switch

The **STANDBY** switch will place the amplifier in the standby mode from the "Operate" mode; it will not cause a reset to occur. The yellow LED will be lit while then unit is in "Standby"; it will be off only when the amplifier's power is off or when the amplifier is in the "Operate" mode. No RF output is possible when the amplifier is in the "Standby" mode.

2.2.4 OPERATE Switch

The **OPERATE** switch will place the amplifier in the "Operate" mode. While the amplifier is in the "Operate" mode, the green LED will be lit and RF output is possible.

2.2.5 RESET Switch

The **RESET** switch will cause the amplifier to attempt to reset. This red LED in the **RESET** switch indicates a fault in the amplifier. Pressing the **RESET** switch may clear the fault, depending upon the type of fault that has occurred. If the amplifier is in an over-driven condition, lowering the amplifier's gain or ALC Threshold or RF input level should enable the switch to reset the amplifier (i.e., the amplifier will be in the "Standby" mode). If pressing the **RESET** switch does not clear the **RESET** LED, refer to the subsection **3.5** ("Fault Detection/Indicator Circuits") and subsection **4.2** ("Using the Digital Control Panel (DCP) to Aid in Troubleshooting") of this manual.

2.2.6 RF Overload Alarm

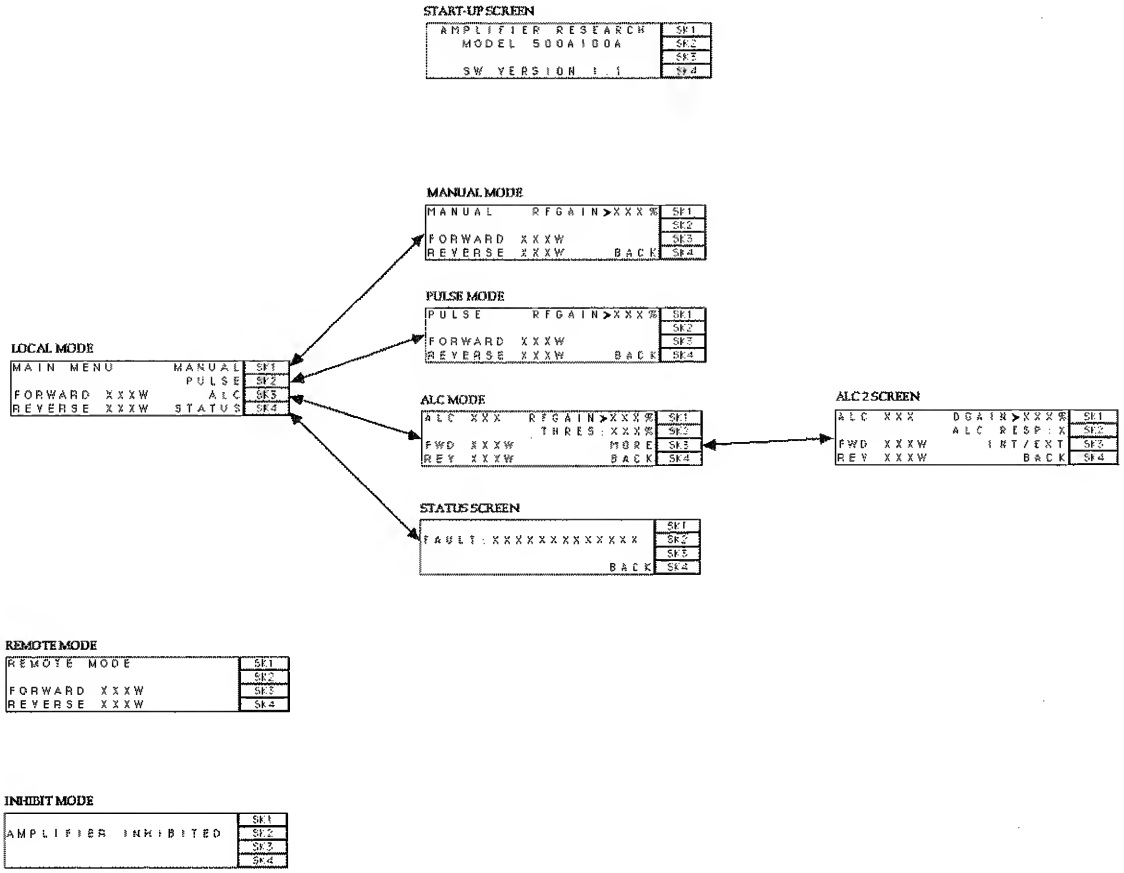
This alarm, which is located behind the front panel door, will sound with a loud, piercing, modulated tone if the amplifier's forward power exceeds approximately **550** watts or if the amplifier's reflected power exceeds approximately **450** watts.

2.3 DIGITAL CONTROL PANEL (DCP) OPERATIONS

The operations described in this subsection assume that the user is performing these operations from the amplifier's front panel with the Keylock Switch in the **LOCAL** position. Computer access to command and status functions is also available when the Keylock Switch is set to **REMOTE**. Refer to "IEEE-488 and RS-232 Command and Status Structures" in subsection **2.5.5** for information on remote operation.

The 4-line vacuum fluorescent display (VFD) (see **Figure 2-1**) is located in the center of the amplifier's front panel. The **POWER, STANDBY, OPERATE,** and **RESET** buttons are located to the left of the VFD. The safety Keylock Switch is located to the left of these controls. To the immediate right of the VFD are four buttons in a column with lines leading to the display. These four keys are referred to below as "soft-keys" to denote that the keys perform a different function on each display. To the right of the soft-keys are two additional keys. These are the directional scroll keys, referred to as **UP, DOWN**. To the far right is an adjust knob. This knob is used to adjust most of the variables shown on the display. The adjust knob's sensitivity changes for the different values it adjusts.

500A100A DISPLAY SCREENS



2.3 DIGITAL CONTROL PANEL (DCP) OPERATIONS *(CONTINUED)*

Each menu display is arranged according to a similar pattern. To the right of the display a label is shown which is used to designate both the name of the adjacent soft-key and the variable that is being adjusted. Most displays include the Forward and Reflected power levels on the two bottom-most lines of the display. These indications are developed using a dual-directional coupler located within the amplifier near the RF output port, and should be used as uncalibrated indicators of approximate power level.

The principal operator displays are designated as follows:

- Main—Initial menu;
- Manual—Manual mode selection for setting the RF Output level.
- Pulse—Pulse mode selection for setting the RF Output level of a gated pulse.
- ALC—Automatic Level Control (ALC) mode selection for setting the RF Output level.
- Status—Observe fault details.

Operator Display Functions are described in the following subsections. General Display Navigation is shown in **Figure 2-3**. Movement through the menus is self-explanatory by using the **MORE** and **BACK** soft-keys.

2.3 DIGITAL CONTROL PANEL (DCP) OPERATIONS *(CONTINUED)*

2.3.1 Selecting Amplifier Operating Mode

Before the amplifier is given the "Operate" command, the user should select the desired operating mode. The available operating modes are as follows:

- Manual
- Pulse (External Pulse Input)
- ALC Internal (Automatic Level Control with Internal Detector)
- ALC External (Automatic Level Control with External Detector)

Each of these operating modes is discussed in the following subsections.

2.3.1.1 Manual Mode

In the Manual mode, the amplifier's RF output level is controlled by the input drive level and the RF Gain control. This mode provides no automatic control of the amplifier's RF output level other than that provided by the amplifier's protective circuitry.

To enter the Manual mode, press the soft-key labeled **"MANUAL"** at the Main menu (see **Figure 2-3**); the screen will then change to the Manual display. RF Gain may be adjusted by using the adjust knob or the **UP/DOWN** scroll keys. The Forward and Reflected power levels are shown on the display at all times. Pressing the **BACK** soft-key will always return the screen to the Main menu.

2.3.1.2 Pulse Mode

In the Pulse mode, the amplifier's RF output level is controlled by the input drive level and the RF Gain control. The front panel **PULSE INPUT** can be used to pulse the RF output by applying a pulsed TTL signal; if the pulse is at a low voltage, the RF is off.

To enter the Pulse mode, press the soft-key labeled **"PULSE"** at the Main menu (see **Figure 2-3**); the screen will then change to the Pulse display. The RF Gain may be adjusted by using the adjust knob or the **UP/DOWN** scroll keys. The Forward and Reflected power levels are shown on the display at all times. Pressing the **BACK** soft-key will always return the screen to the Main menu.

2.3.1.3 Automatic Level Control (ALC) Modes

In these modes, the amplifier is operated in an "Automatic Leveling" mode—that is, the amplifier's RF output level is controlled by its **THRESHOLD, RF GAIN,** and **DETECTOR GAIN** controls. The ALC input (feedback) for this mode can be either Internal (**INT**) or External (**EXT**).

2.3.1 Selecting Amplifier Operating Mode *(continued)*

2.3.1.3 Automatic Level Control (ALC) Modes *(continued)*

To enter the ALC modes, press the soft-key labeled **"ALC"** at the Main menu (see **Figure 2-3**); the screen will then change to the ALC display . The **RF GAIN** and **THRESHOLD ALC** parameters may be adjusted by pressing the appropriate soft-key and adjusting the value by using the adjust knob or the **UP/DOWN** scroll keys; an arrow is displayed next to the active selection. The Forward and Reflected power levels are shown on the display at all times. Pressing the **BACK** soft-key will always return the screen to the Main menu. Pressing the **MORE** soft-key displays the second ALC menu. The Detector Gain (**DGAIN**), ALC Response time constant (**ALC RESP**), and Detector selection (**INT/EXT**) parameters may be adjusted by pressing the appropriate soft-key. An arrow is displayed next to **DGAIN** or **ALC RESP** to indicate which one is active. Pressing the **INT/EXT** soft-key will toggle the detector mode, which is displayed on the top line of the display.

2.3.2 Adjusting Amplifier Controls

All adjustments to control the operation of the Model 500A100A are made using the dedicated controls, display menus with their associated soft-keys, scroll keys, and adjust knob functionality.

2.3.2.1 RF GAIN Control

The **RF GAIN** control, which has a minimum of 25dB of range, is used to adjust the input level to the preamplifier-leveler module. In the Manual or Pulse mode, this control simply adjusts the output power level for a fixed input power level. In the Automatic Level Control (ALC) mode, this control should be set to allow the amplifier to reach the desired output power.

To adjust the RF Gain, select the operating mode (Manual, Pulse, or ALC) as described above, then press the **RF GAIN** soft-key. Adjust the value using the adjust knob or the **UP/DOWN** scroll keys. Please note that the display panel is limited in resolution compared to the control signals, which are generated and sent to the leveler electronics module. A small rotation that may not show any change on the display may, in fact, cause very small, precise changes in the amplifier's RF output.

2.3.2.2 THRESHOLD Control

This control is used to adjust the output RF signal level in the ALC modes only; leveling will not occur if there is not sufficient RF input power to the amplifier. The **THRESHOLD** control is not used in the Manual or Pulse modes.

To adjust the ALC Threshold, select the ALC operating mode as previously described. Press the **THRESH** soft-key. Adjust the value using the adjust knob or the **UP/DOWN/UP/DOWN** scroll keys. Please note that the display panel is limited in resolution compared to the control signals, which are generated and sent to the ALC Threshold control electronics. A small rotation that may not show any change on the display may, in fact, cause very small, precise changes in the amplifier's RF output.

2.3.2 Adjusting Amplifier Controls *(continued)*

2.3.2.3 DETECTOR GAIN Control

This control is used to compensate for gain variations of the ALC loop caused by differences in the detectors that can be used to provide level feedback to the automatic leveling loop.

To adjust the ALC Detector Gain, select the ALC operating mode as previously described. Press the DGAIN soft-key. Adjust the value using the knob or the **UP/DOWN** scroll keys. Please note that the display panel is limited in resolution compared to the control signals, which are generated and sent to the Detector Gain control electronics. A small rotation that may not show any change on the display may, in fact, cause very small, precise changes in the Detector Gain. For Internal ALC operation, this control should be set to approximately 50%.

2.3.2.4 ALC RESPONSE Control

The **ALC RESPONSE** control is used to adjust the frequency response of the ALC loop. This control is particularly useful if the input to the amplifier is a swept signal. By adjusting the speed of the ALC loop, critical damping-without oscillation-can be obtained. A level of 1 is the fastest time constant and a level of 6 is the slowest.

To adjust the frequency response of the ALC loop, select the ALC operating mode as previously described. Press the ALC RESP soft-key. Adjust the value using the adjust knob or the **UP/DOWN** scroll keys. Higher settings slow the ALC loop response, resulting in a more stable but slower-responding ALC. Note that a large rotation of the knob is required to change settings between the seven available discrete values.

2.3.2.5 Detector Internal/External Selection

The ALC mode can be controlled by either an internal or external detector. To select the desired ALC mode, proceed to the ALC display by pressing the ALC soft-key from the Main menu, then press the **MORE** soft-key. Press the **INT/EXT** soft-key to toggle between the Internal and External ALC modes.

DETECTOR INPUT (+) and **DETECTOR INPUT (-)** connectors are located on the unit's front panel for connection to external detector devices, such as field-strength monitors. Both inputs are enabled in the ALC external (**EXT**) mode.

2.4 INPUTS AND OUTPUTS

The input and output connectors described in the following subsections are located on the unit's front and rear panels; refer to the Front and Rear Panel Features drawings (**Figure 2-1, Figure 2-2**).

2.4.1 RF INPUT

This Type "N" connector is the RF input to the amplifier. It should be connected to the RF power source to the amplifier.

2.4 INPUTS AND OUTPUTS *(CONTINUED)*

2.4.2 RF OUTPUT

This Type "N" connector is the RF output of the amplifier.

CAUTION:

DO NOT CONNECT OR DISCONNECT ANY LOADS OR CABLES FROM THE AMPLIFIER'S RF OUTPUT WHEN THE AMPLIFIER IS IN THE "OPERATE" MODE. DANGEROUS VOLTAGES THAT COULD CAUSE SERIOUS INJURY TO THE USER EXIST AT THE RF OUTPUT WHEN THE AMPLIFIER IS UNDER POWER.

2.4.3 DETECTED OUTPUT

This BNC output provides a Direct Current (DC) output voltage that is proportional to the RF output power of the amplifier. The output voltage is approximately +1VDC for an output power of 500 watts.

2.4.4 DETECTED INPUT (+) (Positive)

This BNC input is used for external leveling of the amplifier. This input is connected to an external detector (e.g., an external directional coupler with a detector or a field-strength meter) when it is desired that some external condition control the amplifier output level. The input should go positive with increasing power level, presenting a voltage in the range of 0–5VDC.

Note: This connection is only active when the amplifier is in the External ALC mode.

2.4.5 DETECTED INPUT (-) (Negative)

This BNC input is used for external leveling of the amplifier. This input is connected to an external detector (e.g., an external directional coupler with a detector or a field-strength meter) when it is desired that some external condition control the amplifier output level. The input should go negative with increasing power level, presenting a voltage in the range of 0–5VDC.

Note: This connection is only active when the amplifier is in the External ALC mode.

Note: A differential input may be applied between the positive and negative detector inputs.

2.4.6 PULSE INPUT

This 50Ω input can be used to gate the amplifier to create RF pulses. A low input reduces the amplifier gain by 40dB (minimum); this input is TTL level-compatible. A logical zero (<+0.4VDC) corresponds to no pulse (gain reduced by 40dB), and a logical one (>+2.5VDC) causes the amplifier to be at full gain as set by the **GAIN** control.

Note: This connection is only active when the amplifier is in the Pulse mode.

2.4 INPUTS AND OUTPUTS *(CONTINUED)*

2.4.7 IEEE-488 and RS-232 Interfaces

The Model 500A100A's IEEE-488 and RS-232 remote interfaces allow remote control, via a computer, of all amplifier functions (except for the Keylock Switch position) that can be controlled from the front panel. When the amplifier is in the "Remote" mode (as determined by the position of the Keylock Switch), a special "Remote" display is shown (see **Figure 2-3**). Front panel controls are deactivated, except for the Keylock Switch, which can be rotated to **LOCAL** or **INHIBIT** in order to prevent remote control commands from being executed.

Refer to "IEEE-488 and RS-232 Command and Status Structures" in subsection **2.5.5** for information on remote operation of the amplifier.

2.4.8 AUX (Interlock) Connector

The **AUX** connector (Interlock) interface provides for an external safety switch interlock that will prevent the amplifier from entering or being placed in the "Operate" mode unless an external connection is made. A connection (<5Ω) between Pins 1 and 8 must be completed to operate the amplifier.

2.5 AMPLIFIER OPERATION

2.5.1 Manual Mode

This subsection describes how the amplifier would be setup and calibrated in the Manual mode. For a block diagram of a typical setup, see **Figure 2-4**, "Typical Setup—Manual or Internal ALC Mode."

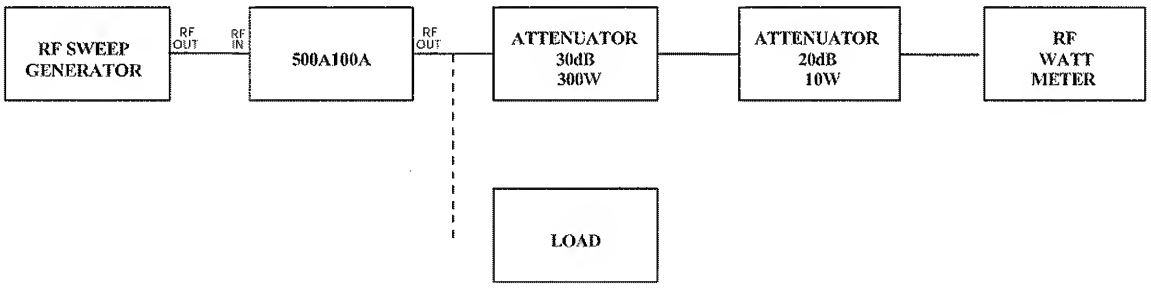


Figure 2-4
Typical Setup—Manual or Internal ALC Mode

2.5.1.1 Preliminary Settings

RF GAIN: 0%

POWER: ON

MODE: MANUAL

2.5 AMPLIFIER OPERATION *(CONTINUED)*

2.5.1 Manual Mode *(continued)*

2.5.1.2 Calibration

Set the RF generator output power to approximately **0dBm** (1mW CW). Place the unit in the "Operate" mode (by pressing the **OPERATE** button). Adjust the manual gain control for the desired signal output level, as measured on the RF wattmeter. You are now calibrated for a given output power from the Model 500A100A. Place the amplifier in the "Standby" mode (by pressing the **STANDBY** button).

CAUTION:

DO NOT CONNECT OR DISCONNECT ANY LOADS OR CABLES FROM THE AMPLIFIER'S RF OUTPUT WHEN THE AMPLIFIER IS IN THE "OPERATE" MODE. DANGEROUS VOLTAGES THAT COULD CAUSE SERIOUS INJURY TO THE USER EXIST AT THE RF OUTPUT WHEN THE AMPLIFIER IS UNDER POWER.

2.5.1.3 Connecting the RF Load

You may now disconnect the amplifier RF output from the attenuator and connect it to the test load (dotted line). After the load has been connected to the Model 500A100A, the amplifier can now be placed in the "Operate" mode by pressing the **OPERATE** button.

2.5.1.4 Repeat the Procedures in Subsections 2.4.1.1 through 2.4.1.3 at Each Test Frequency

2.5.2 Automatic Level Control (Internal Detector) Mode

This subsection describes how the amplifier would be setup and calibrated in the Automatic Level Control (Internal Detector) mode. For a block diagram of a typical setup, see **Figure 2-4**, "Typical Setup: Manual or Internal ALC Mode."

2.5.2.1 Preliminary Settings

POWER:	ON
GAIN:	100%
MODE:	ALC
DETECTOR:	INTERNAL
DETECTOR GAIN:	70%
ALC RESPONSE:	1
THRESHOLD:	0%

2.5.2 Automatic Level Control (Internal Detector) Mode *(continued)*

2.5.2.2 Calibration

Set the RF generator output power to approximately **0dBm** (1mW CW). Place the unit in the "Operate" mode (by pressing the **OPERATE** button). Adjust the threshold control for the desired signal output level, as measured on the RF wattmeter. You are now calibrated for a given output power from the Model 500A100A. Place the amplifier in "Standby" (press the **STANDBY** button).

CAUTION:

DO NOT CONNECT OR DISCONNECT ANY LOADS OR CABLES FROM THE AMPLIFIER'S RF OUTPUT WHEN THE AMPLIFIER IS IN THE "OPERATE" MODE. DANGEROUS VOLTAGES THAT COULD CAUSE SERIOUS INJURY TO THE USER EXIST AT THE RF OUTPUT WHEN THE AMPLIFIER IS UNDER POWER.

2.5.2.3 Connect the RF Load

You may now disconnect the amplifier RF output from the attenuator and connect it to the test load (dotted line). After the load has been connected to the Model 500A100A, the amplifier can be placed in the "Operate" mode by pressing the **OPERATE** button. The RF generator can now be placed in the CW or swept mode and the output power will remain constant to within +/-0.5dB.

2.5.3 Automatic Level Control (External Detector) Mode

This subsection describes how the amplifier would be set up and calibrated in the Automatic Level Control (External Detector) mode. For a block diagram of a typical setup, see **Figure 2-5**, "Typical Setup—External ALC Mode."

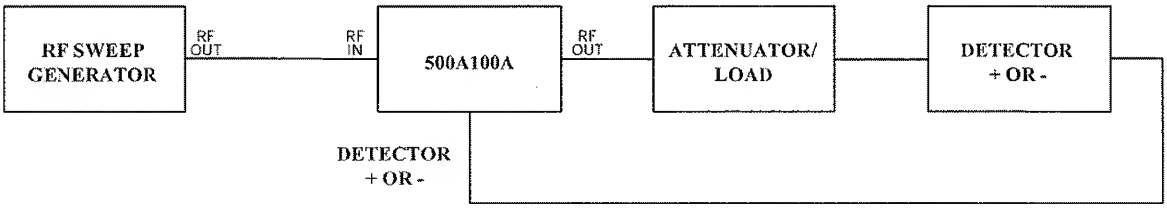


Figure 2-5
Typical Setup—External ALC Mode

2.5.3.1 Preliminary Settings

POWER SWITCH:	ON
GAIN:	100%
MODE:	ALC
DETECTOR:	EXT
DGAIN:	80%
RESPONSE:	4
THRESHOLD:	0%

2.5.3 Automatic Level Control (External Detector) Mode *(continued)*

2.5.3.2 Calibration

Set the RF generator output power to approximately **0dBm** (1mW CW). Place the unit in the "Operate" mode (by pressing the **OPERATE** button). Adjust the Threshold control for the desired signal output level, as measured on the RF wattmeter. You are now calibrated for a given output power from the Model 500A100A. Place the amplifier in "Standby" (press the **STANDBY** button).

CAUTION:

DO NOT CONNECT OR DISCONNECT ANY LOADS OR CABLES FROM THE AMPLIFIER'S RF OUTPUT WHEN THE AMPLIFIER IS IN THE "OPERATE" MODE. DANGEROUS VOLTAGES THAT COULD CAUSE SERIOUS INJURY TO THE USER EXIST AT THE RF OUTPUT WHEN THE AMPLIFIER IS UNDER POWER.

2.5.3.3 Operation

The RF generator can now be placed in the CW or swept mode and the output power will remain constant to within +/-0.5dB. At this time, if the RF generator has been switched to a swept signal the response control can be adjusted to increase the tightness of the ALC loop. The speed of the external detector will determine how fast the ALC loop can be made. For example, if an increase in response time gives no better flatness of the output response, the response control should be decreased to the maximum speed where an improvement in response flatness is observed.

2.5.4 Pulse Mode

This subsection describes how the amplifier would be set up and calibrated in the "Pulse" mode. For a block diagram of a typical setup, see **Figure 2-6**, "Typical Setup—Pulse Mode."

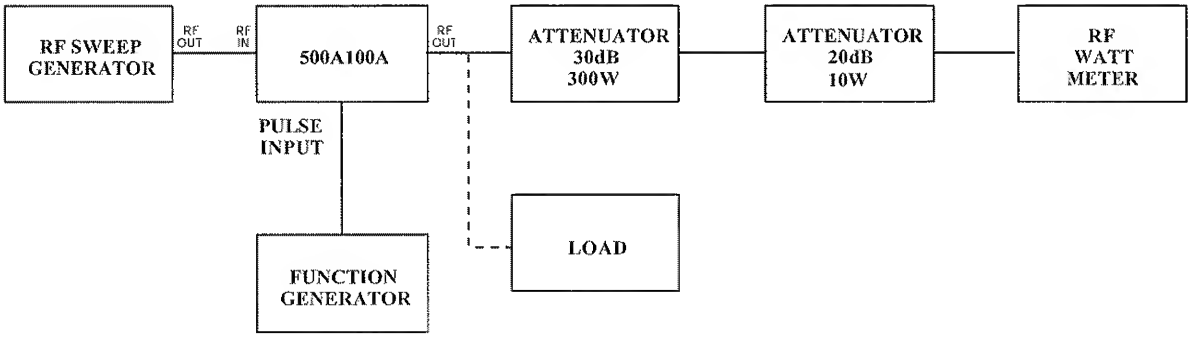


Figure 2-6
Typical Setup—Pulse Mode

2.5.4.1 Preliminary Settings

MANUAL GAIN: 0%

POWER: ON

MODE: MANUAL

2.5.4 Pulse Mode *(continued)*

2.5.4.2 Calibration

Set the RF signal generator output power to approximately **0dBm** (1mW CW). Turn on the power switch. Place the unit in the "Operate" mode (by pressing the **OPERATE** button). Adjust the manual gain control for the desired signal output level, as measured on the RF wattmeter. You are now calibrated for a given output power from the Model 500A100A. Place the amplifier in the "Standby" mode (by pressing the **STANDBY** button).

⚠ CAUTION:

DO NOT CONNECT OR DISCONNECT ANY LOADS OR CABLES FROM THE AMPLIFIER'S RF OUTPUT WHEN THE AMPLIFIER IS IN THE "OPERATE" MODE. DANGEROUS VOLTAGES THAT COULD CAUSE SERIOUS INJURY TO THE USER EXIST AT THE RF OUTPUT WHEN THE AMPLIFIER IS UNDER POWER.

2.5.4.3 Connecting the RF Load

At this time the mode switch can be switched to the Pulse mode, and the function generator can be calibrated for the correct pulse length/duty cycle. You may now disconnect the amplifier's RF output from the attenuator and connect it to the test load (dotted line). After the load has been connected to the Model 500A100A, the amplifier can now be placed in the "Operate" mode by pressing the **OPERATE** button.

2.5.5 Remote Operation

2.5.5.1 Introduction

This subsection describes remote operation of the Model 500A100A amplifier by utilizing either the IEEE-488 parallel interface or the RS-232 serial interface and a controlling device, such as a bus controller or a personal computer (PC).

2.5.5.2 Selecting Remote Operation

The Model 500A100A can be placed in the remote mode at any time by switching the Keylock Switch on the front panel to the **REMOTE** position. In this mode, control is passed to the selected remote interface, and all front panel controls are inoperative with the exception of the Keylock Switch. The amplifier's initial state will be power off, minimum gain; the front panel display will show the **REMOTE** screen (see Figure 2-3).

2.5.5 Remote Operation *(continued)*

2.5.5.3 Interface Selection

The Model 500A100A can be controlled via either the IEEE-488 or RS-232 interfaces. Which interface is active is determined by the position of Switch 6 of the rear panel Dual In-Line Package (DIP) switch located between the two interface connectors. If Switch 6 is in the "on" (1) position, the RS-232 interface will be active. If Switch 6 is in the "off" (0) position, the IEEE-488 interface will be active. (**Note:** These switches are only read at device power-up; in order for changes made in these switch settings to take place, AC power must be removed and then re-applied to the Model 500A100A.)

2.5.5.4 Interface Set-up

Switches 1–5 of the rear panel DIP switch are used to select either the RS-232 communication (BAUD) rate or the IEEE-488 device address, depending upon which interface is active. (**Note:** These switches are only read at device power-up; in order for changes made in these switch settings to take place, AC power must be removed and then re-applied to the Model 500A100A.)

2.5.5.4.1 RS-232 BAUD rate selection

The serial communication (BAUD) rate can be set to five different levels. Selections are made by the positions of Switches 1–5 of the rear panel DIP switch. Following is a list of the available BAUD rates and their corresponding DIP switch positions:

BAUD Rate	**Switch on (1)**
1200	1 only
2400	2 only
9600	3 only
19600	4 only
76800	5 only

(**Note:** Any other combination of switch settings will result in a BAUD rate equal to 1200.)

2.5.5.4.2 IEEE-488 device address selection

The IEEE-488 device address can be set to any number between 1 and 30. This selection is made by setting Switches 1–5 of the rear panel DIP switch to the binary equivalent of the number. **Table 2-1** illustrates this switch selection.

2.5.5 Remote Operation *(continued)*

2.5.5.4 Interface Set-up *(continued)*

2.5.5.4.2 IEEE-488 device address selection *(continued)*

Table 2-1
IEEE-488 Device Address Selection

Device Address	Switch 5	Switch 4	Switch 3	Switch 2	Switch 1
1	off (0)	off (0)	off (0)	off (0)	on (1)
2	off (0)	off (0)	off (0)	on (1)	off (0)
3	off (0)	off (0)	off (0)	on (1)	on (1)
4	off (0)	off (0)	on (1)	off (0)	off (0)
5	off (0)	off (0)	on (1)	off (0)	on (1)
:					
:					
30	on (1)	on (1)	on (1)	on (1)	off (0)

2.5.5.5 Command Set Format

Each command is composed of one alpha character, up to four numeric parameters, and a command termination character. The command termination character is the "line feed" command, which is denoted and entered as <LF>. Commands are case-sensitive and must be entered in upper case only in order to be recognized.

2.5.5.6 IEEE-488 Communications

For IEEE-488 communications, the "End or Identify" (EOI) control line may also be used for command termination. When sending commands to the Model 500A100A via the IEEE-488 bus, terminate each command with a <LF>, an EOI, or both. No characters are permitted after the <LF> or EOI; the 500A100A interprets characters following the <LF> or EOI as the start of the next command. When an error condition is present at the Model 500A100A, the "Service Request" (SRQ) line is asserted; the operator can then perform a serial poll operation. The Model 500A100A error code (in binary) is contained in the returned serial poll status byte (STB). These error codes are defined in **Table 2-2**.

2.5.5 Remote Operation *(continued)*

2.5.5.6 IEEE-488 Communications *(continued)*

Table 2-2
Remote Error Codes/Messages

IEEE-488 SERIAL POLL POLL RESPONSE (STB) (binary)/decimal	MODEL 500A100A ERROR CONDITION	RS-232 ERROR MESSAGE
(01000001) 65	PA1 AMP FAULT	E1
(01000010) 66	PA2 AMP FAULT	E2
(01000011) 67	PA3 AMP FAULT	E3
(01000100) 68	THERMAL FAULT	E4
(01000101) 69	+38VDC FAULT	E5
(01000110) 70	+28VDC FAULT	E6
(01000111) 71	AC PWR FAULT	E7
(01001000) 72	RF FAULT	E8
(01001001) 73	INTERLOCK FAULT	E9

2.5.5.7 RS-232 Communications

If the RS-232 interface is active, the Model 500A100A will test for a properly connected RS-232 interface when switched into the "Remote" mode. In order for the Model 500A100A to recognize an RS-232 connection, the "Data Carrier Detect" (DCD) line must be asserted. This line is sampled continuously in order to determine if the RS-232 connection is broken; therefore, it must remain asserted in order for the RS-232 interface to function. The "Clear To Send" (CTS) line is also used to gate information from the Model 500A100A. This line must be asserted in order to receive information from the Model 500A100A. The CTS line can be used as a "handshake" line to inform the Model 500A100A when it is permissible to send information. If the CTS line is de-asserted in the middle of a transmission, the character in the process of being transmitted will be completed and further transmission will halt until the CTS line is re-asserted. The Model 500A100A itself asserts two lines: "Data Terminal Ready" (DTR) and "Request To Send" (RTS). The DTR line is continuously asserted, while the RTS line is used to gate information into the Model 500A100A. Connector pin-out information is given in **Table 2-3**.

2.5.5 Remote Operation *(continued)*

2.5.5.7 RS-232 Communications *(continued)*

Table 2-3
RS-232 Connector Pin-Outs

Pin No.	Signal	Data Direction*	Description
1	DCD	<	Device Carrier Detect
2	RD	<	Receive Data
3	TD	>	Transmit Data
4	DTR	>	Data Terminal Ready
5	GND	N/A	Ground
6	NC	N/A	No Connection
7	RTS	>	Ready To Send
8	CTS	<	Clear To Send
9	NC	N/A	No Connection

***Note:**

>=Output from the Model 500A100A

<=Input to the Model 500A100A

Special Note: A null modem cable or adapter is required in order to properly interface the Model 500A100A to a standard serial port on a computer.

Once the RS-232 interface is established, commands are processed in the same manner as that of the IEEE-488 interface; the command structure is identical except that there is no EOI line. Therefore, all commands are terminated with a line feed (<LF>). Since this is a full-duplex asynchronous interface, if the Model 500A100A detects an error, the error message is immediately transmitted to the host controller. These error messages are defined in **Table 2-2**.

2.5.5.7.1 RS-232 port settings

The RS-232 port settings used for communication with the Model 500A100A are as follows.

Word Length: 8 bits

Stop Bits: 1

Baud Rate: 1200–76,800 (switch-selectable)

Parity: None

2.5.5 Remote Operation *(continued)*

2.5.5.8 Remote Commands

The following commands are available to the user for remote communication and operation of the Model 500A100A. In the descriptions of these commands, a lower-case "x" is used to signify a numeric value or a parameter.

2.5.5.8.1 Power On/Off

Controls the power on/off state of the Model 500A100A.

Syntax: Px

Parameters: 0=Power Off

1=Power On

Example: To turn the power on, send the following command:

P1<LF>

2.5.5.8.2 Standby

Places the Model 500A100A into the "Standby" mode:

Syntax: S

Parameters: None

Example: To place the amplifier into the Standby mode, send the following command:

S<LF>

2.5.5.8.3 Operate

Places the Model 500A100A into the "Operate" mode:

Syntax: O

Parameters: None

Example: To place the amplifier into the "Operate" mode, send the following command:

O<LF>

2.5.5.8.4 Reset

Clears faults and resets the Model 500A100A:

Syntax: R

Parameters: None

Example: To reset the amplifier, send the following command:

R<LF>

2.5.5 Remote Operation *(continued)*

2.5.5.8 Remote Commands *(continued)*

2.5.5.8.5 Manual Mode

Places the Model 500A100A into the Manual mode:

Syntax: MM

Parameters: None

Example: To place the amplifier into the Manual mode, send the following command:

MM<LF>

2.5.5.8.6 Pulse Mode

Places the Model 500A100A into the Pulse mode:

Syntax: MP

Parameters: None

Example: To place the amplifier into the Pulse mode, send the following command:

MP<LF>

2.5.5.8.7 ALC Mode

Places the Model 500A100A into the Automatic Level Control (ALC) mode:

Syntax: MA

Parameters: none

Example: To place the amplifier into the ALC mode, send the following command:

MA<LF>

2.5.5.8.8 Internal Detector

To select the Internal Detector for automatic leveling:

Syntax: DI

Parameters: None

Example: To select the Internal Detector, send the following command:

DI<LF>

2.5.5 Remote Operation *(continued)*

2.5.5.8 Remote Commands *(continued)*

2.5.5.8.9 External Detector

To select an External Detector for automatic leveling:

Syntax: DE

Parameters: None

Example: To select an External Detector, send the following command:

DE<LF>

2.5.5.8.10 RF Gain

Sets the remote gain level of the Model 500A100A with 4095 steps of resolution.

Syntax: Gxxxx

Parameters: 0000=Minimum Gain

:

:

4095=Maximum Gain

Example: To set the Model 500A100A to Minimum Gain, send the following command:

G0000<LF>

2.5.5.8.11 ALC Threshold

Sets the remote ALC Threshold level of the Model 500A100A with 4095 steps of resolution.

Syntax: Txxxx

Parameters: 0000=Minimum ALC Threshold

:

:

4095=Maximum ALC Threshold

Example: To set the Model 500A100A to the Minimum ALC Threshold, send the following command:

T0000<LF>

2.5.5 Remote Operation *(continued)*

2.5.5.8 Remote Commands *(continued)*

2.5.5.8.12 Detector Gain

Sets the remote ALC Detector Gain of the Model 500A100A with 255 steps of resolution.

Syntax: Dxxx

Parameters: 000=Minimum Detector Gain

:

:

255=Maximum Detector Gain

Example: To set the Model 500A100A to Minimum Detector Gain, send the following command:

D000<LF>

2.5.5.8.13 ALC Response

Sets the remote ALC response time constant of the Model 500A100A with 7 steps of resolution.

Syntax: LRx

Parameters: 0=Fastest ALC Time Constant

:

:

6=Slowest ALC Time Constant

Example: To set the Model 500A100A to the fastest ALC Time Constant, send the following command:

LR0<LF>

2.5.5.8.14 RF Gain Status

To request the present RF Gain setting:

Syntax: G?

Parameters: None

Example: To request the present RF Gain setting, send the following command:

G?<LF>

Responds with **G0000–G4095** (G0000=Minimum RF Gain)

2.5.5 Remote Operation *(continued)*

2.5.5.8 Remote Commands *(continued)*

2.5.5.8.15 ALC Threshold Status

To request the present ALC Threshold setting:

Syntax: T?

Parameters: None

Example: To request the present ALC Threshold setting, send the following command:

T?<LF>

Responds with **T0000–T4095** (T0000=Minimum ALC Threshold)

2.5.5.8.16 Detector Gain Status

To request the present Detector Gain setting:

Syntax: D?

Parameters: none

Example: To request the present Detector Gain setting, send the following command:

D?<LF>

Responds with **D000–D255** (D000=Minimum Detector Gain)

2.5.5.8.17 ALC Response Status

To request the present ALC Time Constant setting:

Syntax: LR?

Parameters: None

Example: To request the present ALC Time Constant setting, send the following command:

LR?<LF>

Responds with **LR0–LR6** (LR0=Fastest Time Constant)

2.5.5.8.18 Forward RF Power Status

To request the present RF Output Forward Power reading:

Syntax: FP?

Parameters: None

Example: To request the present RF Output Forward Power reading, send the following command:

FP?<LF>

Responds with **FP0000–FP2048**

P(watts)=(xxxx/2048) X 750

2.5.5 Remote Operation *(continued)*

2.5.5.8 Remote Commands *(continued)*

2.5.5.8.19 Reflected RF Power Status

To request the present RF Output Reflected Power reading:

Syntax: RP?

Parameters: None

Example: To request the present RF Output Reflected Power reading, send the following command:

RP?<LF>

Responds with **RP0000–RP2048**

P(watts)=(xxxx/2048) X 750

2.5.5.8.20 Identity Request

To request the identity of the Model 500A100A:

Syntax: I?

Parameters: None

Example: To request the identity of the Model 500A100A, send the following command:

I?<LF>

Responds with **IAR500A100ASWx**

SECTION III

THEORY OF OPERATION

3.1 GENERAL

The Model 500A100A is a relatively simple unit to understand. The amplifier chain is a straightforward design, with a few control elements in the lineup. The power supply section consists of two (2) self-contained, replaceable, switching power supplies.

3.2 AMPLIFIER

For reference, see **Figure 3-1**, "Signal Flow Diagram—Model 500A100A."

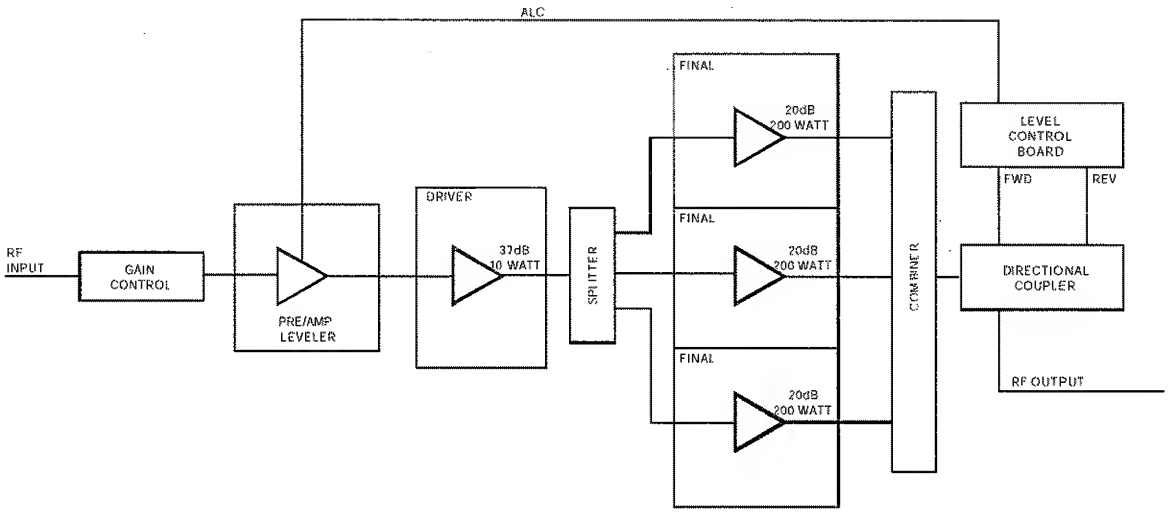


Figure 3-1
Signal Flow Diagram—Model 500A100A

From the RF input, the signal path is as follows. From the BNC connector on the front panel, the signal is connected to the gain control, which is then connected to the preamplifier-leveler. This preamplifier-leveler consists of a diode limiter, a fixed resistive attenuator, an electronic attenuator, and three (3) hybrid gain stages. The diode limiter is the first protection against overdriving the input. The electronic attenuator is controlled by either the protection circuitry (RF overload), the ALC mode circuitry, or the Pulse mode circuitry. Finally, the three (3) hybrid gain stages bring the signal level back up to a maximum of +10dB over the input. The preamplifier-leveler is powered by +15VDC and -15VDC.

The next element is the ten-watt driver amplifier, which is located on the RF heat sink. This amplifier has approximately 37 dB of gain and is capable of putting out 10 watts of power; it is powered by +28VDC. After this 10-watt amplifier, the output is split by a three-way splitter, which in turn drives three 200-watt final amplifier modules. All of these modules are located on the RF heat sink.

3.2 AMPLIFIER *(CONTINUED)*

The output from these three modules is combined into one output by a three-way combiner located on the RF heat sink. This single output then passes through a self-contained directional coupler with built-in detectors for monitoring forward and reflected power levels. The detected outputs from this coupler are used by the level control circuit, the fault control circuits, and the power meter. The directional coupler is mounted with the output through the front panel.

3.3 POWER SUPPLY

For reference, see Schematic Diagram Number **1009897**, "Interconnect Diagram, Model 500A100A."

Line power to the unit is supplied by 180–264 VAC. A 20-amp circuit breaker (CB1), which is located on the rear panel, protects the unit in case of a short. A power relay (K1) delivers line voltage from the circuit breaker to the self-contained switching power supplies, which supply +38VDC to the 200-watt final amplifier modules and 28VDC to the rest of the unit's circuitry. The power relay (K1) is controlled by the front panel display assembly. The +28VDC output voltage is regulated to +26VDC Fan and filtered +28VDC by the regulator assembly. The front panel Keylock Switch allows the +24VDC power supply to enable the front panel controls.

3.4 CONTROL CIRCUITS

3.4.1 Control Circuits

This subsection describes the internal operation of the Model 500A100A's controls. Assume that CB1 is closed and the unit is in the power-off mode. At this time all power supplies are off except the high-reliability, low-voltage, "keep-alive" power supply. This power supply provides power to all control PCBs within the Model 500A100A.

When the power switch is turned on, the power relay is energized and the +28VDC power supply turns on supplying power to the driver and fans; the vacuum fluorescent display (VFD) is also turned on. No power is supplied to the final RF power amplifiers. The unit is now in the standby mode. The fans should be running at their low-speed mode (to reduce noise and prolong fan life), and the power and standby LEDs should be illuminated.

When the **OPERATE** button is closed, the display assembly removes the 5V disabling signal from the 38V switching power supply, and +38VDC power is delivered to each RF final amplifier. The cooling fans should now be in their high-speed mode. The front panel display should show SYSTEM OK on the STATUS screen.

An RF overload condition will turn off power to final amplifiers, set the pre-driver to minimum gain, and will turn on the fault LED. The driver will remain in the energized state. Power can be restored by reducing the RF signal level and pressing the reset switch. Any other faults or interlock discontinuities will turn off power to the RF finals. The front panel display will list the fault under the status screen. After the problem is corrected and the reset switch is pressed, the amplifier will be in a standby state.

The front panel display assembly is a multiprocessor control microcontroller that is not serviceable without access to the proper logic analyzer, emulator, and computer source code. Outside of a visual inspection of the assembly, cabling, and connectors, no in-field debugging is possible.

3.4 CONTROL CIRCUITS *(CONTINUED)*

3.4.2 Level Control Circuits

This subsection describes the operation of the level control board. For reference, see Schematic Diagram Number **1008245-501**, "Level Control Circuit." In general, the level control board performs the following functions:

- Provides automatic level control of the amplifier's output when the amplifier is placed in the Automatic Level Control (ALC) mode.
- Limits RF input level to the amplifier and turns on the audio alarm when forward or reflected power levels exceed specified levels.
- Sends a fault signal to the fault control board when the limiting previously described has failed to control the output power. This signal ultimately turns off power to the final amplifiers.
- Drives the forward and reflected indicators on the front panel and remote computer hosts.
- A pulse input signal from the front panel control is also used to provide pulsed output from the amplifier.

The above functions are described electrically below.

Voltages are received from the directional coupler located on the amplifier's output, which are proportional to the amplifiers forward and reflected powers. These voltages are amplified by U1 to provide +1VDC at pin 1 and pin 2 with an input proportional to the 500-watt level.

From pin 1, the forward signal voltage is picked up by four buffer stages. The buffer U2/B is calibrated to drive the front panel indicator for forward power. U2/A is used as a buffer to control the leveling preamplifier in the "ALC—Internal Detector" mode of operation. U2/B drives the detected output connector on the front panel; the other buffer (U2/C) is not used. The fifth opamp, U7/A, contributes to the RF overload protection circuitry.

The Reverse power path is identical to the forward signal flow.

The buffer U5 drives three separate circuits to provide RF overload protection, and it is driven by either U4 (forward) or U9 (reflected), whichever is more positive. U5 drives U6 and U7, comparators for the audio alarm and the overload fault detector, respectively.

The outputs of U7 are diode ORed, which drive and protection loop integrator, which limits the maximum amount of forward or reverse power outputted by the amplifier. The output of this integrator is ORed with gain control and ALC control signals through U11, which controls the attenuator of the leveling preamplifier, and can be brought low by its strobe input, which is driven by Q2 and the pulse input.

If the forward or reverse limit circuit (U6) becomes active, an audio alarm will sound, warning the operator.

3.4 CONTROL CIRCUITS *(CONTINUED)*

3.4.2 Level Control Circuits *(continued)*

The Automatic Level Control (ALC) circuitry takes its input from either the internal source U2/A, via a switch (U13) (Internal ALC) or from either the + or - inputs on the front panel (External ALC). These voltages drives the differential amplifier U14, whose output is sent to the digital potentiometer U4.. The threshold voltage sent to ALC loop integrator U3 is sent from the display assembly via U8. The ALC gain is adjustable via U12 and the front panel display. U11 drives the attenuator in the preamplifier-leveler assembly, thereby completing the ALC loop. The pulse input drives the attenuator in the preamplifier-leveler to provide pulse control of the amplifier via Q3, Q2, and the strobe input of U11.

3.5 FAULT DETECTION/INDICATOR CIRCUITS

This subsection describes the function and theory of the fault detection/indication circuits which protect the Model 500A100A from damage. For reference, see Schematic Diagram Number **1009460**, "Fault Control Assembly."

3.5.1 Thermal Faults

Thermal protection is provided by a thermal switch on each of the final amplifiers. These switches are connected in series and are normally closed. When any switch senses a temperature higher than its predetermined value, it opens, and this will cause a "High" signal to appear at the thermal sensor's input to the fault control board. This input is polled by the onboard microcontroller and sent to the display assembly to be indicated on the front panel. Any fault puts the unit into the "Standby" mode until it is reset. The fans continue to run to cool down the amplifier.

3.5.2 RF Overload Faults

An RF overload fault would be detected on the level control board, which sends a corresponding signal to the fault control board. This signal is polled and displayed on the front panel.

3.5.3 Final RF Amplifier Faults

Protection from over-dissipation in the FETs of the final RF amplifiers is provided by the current-limiting circuits located on each of the three final RF amplifiers. If any one of the final RF amplifier's DC current limiting circuits are unsuccessful in controlling the input current, a fault signal is sent to the fault control board, a fault indication is displayed on the front panel, and the unit is put into the "Standby" mode.

3.5 FAULT DETECTION/INDICATOR CIRCUITS *(CONTINUED)*

3.5.4 Low-Voltage Faults

Low-voltage protection is provided by window comparators that monitor the +38VDC and +28VDC power supplies. A low-voltage output which is outside of it's "normal" range will send the unit into standby, display the fault on the front panel and the status LED of the failed power supply will change from green to red.

Once a fault has been detected and the problem is rectified, closing the momentary reset switch will reset the unit normal operation of the amplifier may resume.

3.6 FRONT PANEL CONTROLS

This subsection is a brief description of the Model 500A100A's front panel controls; it includes only an electrical and interconnect description. For a functional description of these controls, refer to **Section II** of this manual. For reference, see Schematic Diagram Number **1009897**, "Interconnect Diagram, Model 500A100A."

SECTION IV

TROUBLESHOOTING AND REPAIR

4.1 GENERAL

CAUTION:

EXTREME CAUTION SHOULD BE EXERCISED WHEN TROUBLESHOOTING THE MODEL 500A100A, PARTICULARLY WHEN MEASURING VOLTAGES IN THE POWER SUPPLY SECTION, AS HAZARDOUS VOLTAGES THAT COULD CAUSE SERIOUS INJURY TO THE USER EXIST IN THE AMPLIFIER WHEN IT IS UNDER POWER. PLEASE NOTE THAT NEITHER THE KEYLOCK SWITCH NOR THE POWER SWITCH WILL COMPLETELY SHUT OFF THE UNIT'S AC POWER.

Since it is a relatively simple instrument, the Model 500A100A should require very little maintenance. It is built with printed wiring boards (PWBs) and solid state devices that should ensure a long, trouble-free life. Should trouble occur, special care must be taken when servicing the unit to avoid damaging the PWBs and solid state devices.

Since the components are soldered in place, substitution of components should not be resorted to unless there is some indication that they are faulty. In addition, take care when troubleshooting not to short voltages across the amplifier. Small bias changes may damage the amplifier due to excessive dissipation or transients.

Components within Amplifier Research instruments are conservatively operated to provide maximum instrument reliability. In spite of this, parts may fail. Usually, the instrument must be immediately repaired with a minimum of "down time." A systematic approach can greatly simplify and thereby speed up repair. Incorporated into the Model 500A100A are fault control and protection circuits; all faults are displayed on the unit's front panel VFD. For a description of how these indicators can be used to assist in troubleshooting the unit, see subsection **4.2**, "Using The Digital Control Panel (DCP) to Aid in Troubleshooting."

Due to the importance of maintaining the amplifier's alignment, it is recommended that the unit be returned to the factory for part replacement and amplifier realignment when failure is caused by a failure of any of the components in the amplifier's signal circuits. Shipping instructions are as follows.

Ship the unit **PREPAID** via Motor Freight to:

Amplifier Research Corporation

160 School House Road

Souderton, PA 18964-9990 USA

4.2 USING THE DIGITAL CONTROL PANEL (DCP) TO AID IN TROUBLESHOOTING

⚠ CAUTION:

EXTREME CAUTION SHOULD BE EXERCISED WHEN TROUBLESHOOTING THE MODEL 500A100A, PARTICULARLY WHEN MEASURING VOLTAGES IN THE POWER SUPPLY SECTION, AS HAZARDOUS VOLTAGES THAT COULD CAUSE SERIOUS INJURY TO THE USER EXIST IN THE AMPLIFIER WHEN IT IS UNDER POWER. PLEASE NOTE THAT NEITHER THE KEYLOCK SWITCH NOR THE POWER SWITCH WILL COMPLETELY SHUT OFF THE UNIT'S AC POWER.

The Model 500A100A incorporates some relatively sophisticated fault control and indicator circuitry. Usually status screen of the digital front panel can speed troubleshooting of the amplifier immensely. If the fault LED is lit (red) the first step should be to turn off RF power to the unit and press the reset switch to see if the fault clears. If the fault clears, slowly bring the amplifier's RF drive level back up and ensure that recommended RF power levels are not exceeded. If the fault does not clear with the RF drive off, some other problem probably exists in the amplifier. Go to the status screen on the display to read the recorded fault.

Some examples of how these indicators would be used are as follows.

4.2.1 Power Supply Faults

If a +38V or +28V power supply fault is reported, open the bottom cover and inspect the status lights on the large power supply. In the power-on mode, all LEDs should be green except the +38VDC module. The +38V power supply will not be on unless the unit is in the "Operate" mode. A fault of this kind could be caused by a defective power supply, bad inhibit control voltages, or a bad status signal.

4.2.2 Thermal Fault

This is probably an indication of a fan failure or that the air flow path has been blocked.

4.2.3 Amplifier Fault

A red amplifier fault indicator LED means that one of the amplifier modules has drawn too much current. This can be caused by severe input overdrive into bad VSWRs or a blown device in the amplifier chain. The front panel will indicate which module is faulted.

4.2.4 RF Overload Fault

As stated previously, an RF overload condition can usually be corrected by reducing RF input drive to the unit.